

REMARKS

Applicant has carefully reviewed and considered the Office Action mailed on April 14, 2003, and the references cited therewith.

Claims 1, 12, 25, 26, 27, 32, 44, 45, and 47 are amended, no claims are canceled, and no claims are added; as a result, claims 1-9, 11-14, 16-41, and 43-57 are now pending in this application. Reconsideration of the claims is respectfully solicited.

First §103 Rejection of the Claims

Claims 1-9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Lu et al. (U.S. Patent Application Publication No. 2002/0100693) in view of Charneski et al. (U.S. Patent No. 6,284,652) and Ho et al. (U.S. Patent No. 6,261,954).

The Lu et al. published patent application is a removable reference under 35 U.S.C. §102(e). Applicant reserves the right to swear behind the Lu et al. published patent application at a latter date but chooses at this time to merely distinguish the Lu et al. patent application.

The Charneski et al. patent is a removable reference under 35 U.S.C. §102(e). Applicant reserves the right to swear behind the Charneski et al. patent at a latter date but chooses at this time to merely distinguish the Charneski et al. patent.

The Ho et al. patent is a removable reference under 35 U.S.C. §102(e). Applicant reserves the right to swear behind the Ho et al. patent at a latter date but chooses at this time to merely distinguish the Ho et al. patent.

The Office Action states:

Lu teaches a method of metallizing a substrate, comprising (See paragraphs [0012] to [0020] and FIGS. 1-2D):

depositing on the substrate 102 a dual-purpose layer 114 comprises a material capable of reducing diffusion of the conductive interconnect material into surrounding materials (Paragraph [0017]), and wherein the dual-purpose layer comprises a material having a resistivity that allows electrochemically deposition of the conductive interconnect material (paragraph [0023J];

electrochemically reducing oxides on the surface of the dual-purpose layer using a first electrolyte where the first electrolyte is the cation of the anode in an electrochemical reaction (paragraph [0019]); and,

electrochemically depositing a conductive interconnect layer 120 comprises copper on the surface of the dual-purpose layer (Paragraph [0022]).

Lu fails to explicitly disclose electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer using a second electrolyte as recited in present amended claim I.

Charneski discloses electrochemically depositing a conductive interconnect layer 48 on the surface of the dual-purpose layer using a second electrolyte wherein the conductive interconnect comprises copper and the electrolyte comprises copper sulfate and wherein the first electrolyte is the cation of the anode in an electrochemical reaction cell (col. 8, lines 12-41 and FIG. 4). It would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching of Lu and Charneski to enable the conductive interconnect layer of Lu to be formed and furthermore to control the nature of the copper deposit (col. 8, line 29).

Lu fails to teach wherein the dual-purpose layer comprises tungsten as recited in present claims 3-4.

Ho teaches a dual-purpose layer 18 comprises tungsten (col. 3, lines 30-41 and FIG. 6). It would have been obvious to one of ordinary skill in the art of making semiconductor devices to incorporate Ho's teaching into Lu's method because in doing so the dual-purpose layer comprises of tungsten can eliminate out-diffusion of copper ions from the interconnect (col. 3, lines 30-41).

Lu fails to teach the ranges of the voltage and current applied during both the electrochemically reducing and depositing step as recited in present claims 6-9.

However, there is no evidence indicating that the voltage and current applied during both the electrochemically reducing and depositing step are critical and it has been held that it is not inventive to discover the optimum or workable ranges of a result-effective variable within given prior art conditions by routine experimentation. See MPEP 2144.05.

In the Office Action mailed April 14, 2003, the Examiner described layer 114 of the Lu et al. patent as a "dual-purpose" layer. In fact, layer 114 in the Lu et al. patent has a single-purpose: to prevent diffusion of copper. Layer 116 is a copper seed layer which is deposited on top of the barrier layer 114, with bulk copper 120 electrochemically deposited on top of the seed layer 116. Applicant respectfully submits that the barrier layer in the Lu et al patent is not "a material having a resistivity that allows electrochemical deposition of the conductive interconnect material" as described more fully in claim 2. For the sake of clarity, however, Applicant chooses to amend claim 1 to more clearly point out the two uses of the dual-purpose layer.

Applicant has amended independent method claim 1 to more clearly point out the two purposes of the dual-purpose layer by including the limitation "wherein a first purpose is to serve

as a barrier layer and a second purpose is to serve as a seed layer.” This limitation is not found in the combination of the Lu et al. Patent Application Publication, the Charneski et al. patent and the Ho et al. patent.

The Lu et al. Patent Application Publication describes separate seed layers 116 and barrier layers 114. There is no layer that serves the dual purpose of a seed layer for the cooper and as a barrier layer to prevent diffusion. In Figure 2D of the Lu et al. Patent Application Publication the seed layer 116 is omitted between the copper line 120 and the barrier layer 114 because “the copper 120 (which incorporates seed layer 116)” is all that is shown. See paragraph [0023].

The Charneski et al. patent describes a separate seed layer 20 and a barrier layer 14. It fails to show a dual-purpose layer in which a first purpose is to serve as a barrier layer and a second purpose is to serve as a seed layer. In fact, the Charneski et al. patent describes depositing a diffusion barrier material 14, depositing a copper seed layer 20 by CVD and depositing bulk copper on top of the copper seed layer.

The Ho et al. patent similarly describes a separate barrier layer 18 and a copper seed layer 30. Once again, the final figures fail to show the seed layer, although they are indeed there. In column 4, lines 22-27 of the Ho et al. patent, the seed layer is described as used to catalyze the plating reaction. See also Figures 4 and 5.

In contrast to all three of these references, the present invention described in claim 1 uses a single layer to accomplish both purposes: to act as both a barrier layer and a seed layer. Because the combination of the Lu et al. Patent Application Publication, the Charneski et al. patent and the Ho et al. patent fail to teach such a dual-purpose layer, all the limitations of Applicants claims are not found in the references cited. Therefore, Applicant believes the rejection under 35 U.S.C. § 103(a) now fails. Reconsideration of independent method claim 1, and claims 2-9 which depend upon claim 1, is respectfully solicited.

Second §103 Rejection of the Claims

Claims 11-14, 16-41, and 43-57 were rejected under 35 USC § 103(a) as being unpatentable over Lu et al. in view of Charneski et al., Yamashita et al. (JP 2000351622), Ho et al. and Calvert et al. (U.S. Pub. No. 2002/0134684).

Lu teaches a method of metallizing a substrate, comprising (See paragraphs [0012] to [0020] and FIGS. 1-2D):

depositing on the substrate 102 a dual-purpose layer 114 (paragraph [0023]);

electrochemically reducing oxides on the surface of the dual-purpose layer in an electrochemical reaction cell comprising an anode formed from a material that can be oxidized in the presence of the material comprising the dual-purpose layer (paragraph [0019]) and,

electrochemically depositing a conductive interconnect layer 120 comprises copper on the surface of the dual-purpose layer wherein the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell using a single anode (Paragraph [0022]).

Lu teaches wherein the first electrolyte comprises the cation of the material from which the conductive interconnect layer is made a complexing agent (boric acid H_3BO_3) and a pH control agent (tetramethyl ammonium hydroxide $(CH_3)_4NOH$) wherein the electrolyte exhibits a pH (≥ 4) ([paragraph 0020]). Thus, there is no evidence indicating that the pH ranges as recited in present claims 38-41 and 50-53 are critical and it has been held that it is not inventive to discover the optimum or workable ranges of a result-effective variable within given prior art conditions by routine experimentation. See MPEP 2144.05.

Charneski discloses electrochemically depositing a conductive interconnect layer 48 on the surface of the dual-purpose layer using a second electrolyte wherein the conductive interconnect comprises copper and the electrolyte comprises copper sulfate and wherein the electrochemical reaction cell or bath contains a first electrolyte comprising the cation of the material used to form the anode (col. 8, lines 12-41 and FIG. 4). It would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching of Lu and Charneski to enable the anode of Lu to be formed such that the electrochemically reducing step is performed in a first electrochemical reaction cell using a first anode and the electrochemically depositing step is performed in a second electrochemical reaction cell using a second anode.

Lu fails to teach where in the anode is formed from titanium or titanized platinum as recited in present claims 11 and 13. However, the use of titanium or titanized platinum in forming the anode is well-known to one of ordinary skill in the art of making semiconductor devices.

None of the references disclose wherein the first electrolyte comprises titanium trichloride and titanium sulfate as recited in present claims 13-14, 26, and 27.

JP20003 S 1622 discloses wherein the first electrolyte comprises titanium sulfate having a complexing agent a pH control agent (0-5) and wherein the first anode is formed from titanium (Abstract). It would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching

of Lu and JP20003 51622 to enable the first electrolyte of Lu to be formed.

Lu fails to teach wherein the dual-purpose layer comprises tungsten as recited in present claims 20-21 and 43.

Ho teaches a dual-purpose layer 18 comprises tungsten (col. 3, lines 30-41 and FIG. 6). It would have been obvious to one of ordinary skill in the art of making semiconductor devices to incorporate Ho's teaching into Lu's method because in doing so the dual-purpose layer comprises of tungsten can eliminate out-diffusion of copper ions from the interconnect (col. 3, lines 30-41).

Lu fails to teach the ranges of the voltage and current applied during both the electrochemically reducing and depositing step as recited in present claims 28-31 and 54-57.

However, there is no evidence indicating that the voltage and current applied during both the electrochemically reducing and depositing step are critical and it has been held that it is not inventive to discover the optimum or workable ranges of a result-effective variable within given prior art conditions by routine experimentation. See MPEP 2144.05.

None of the references disclose wherein the complexing agent is ethylene diamine tetra acetate as recited in present claim 47.

Calvert discloses wherein the complexing agent is ethylene diamine tetra acetate (paragraph [0050]) as recited in present claims 35 and 47. It would have been obvious to one of ordinary skill in the art of making semiconductor devices to combine the teaching of Lu and Calvert to enable the complexing agent of Lu to be formed.

Applicant has amended independent method claims 12, 25, 26, 27, 32, 44, 45 and 47 to more clearly point out the two purposes of the dual-purpose layer by including the limitations that a first purpose of the dual-purpose layer is to serve as a barrier layer and a second purpose is to serve as a seed layer. As described more fully above, this limitation is not found in the combination of the Lu et al. Patent Application Publication, the Charneski et al. patent and the Ho et al. patent. As described more fully below, the additional references to Yamashita et al. (JP 2000351622) and Calvert et al. Patent Publication do not supply the missing elements of claims 11-14, 16-41, and 43-57.

The Calvert et al. Patent Publication is a removable reference under 35 U.S.C. §102(e). Applicant reserves the right to swear behind Calvert et al. Patent Publication at a latter date but chooses at this time to merely distinguish Calvert et al. Patent Publication.

The Calvert et al. Patent Publication also describes separate barrier layers and separate copper interconnect layers. See paragraph [0028]. There are no dual-purpose layers in the Calvert et al. Patent Publication.

The Yamashita et al. (JP 2000351622) publication is a removable reference under 35 U.S.C. §102(e). Applicant reserves the right to swear behind the Yamashita et al. publication at a latter date but chooses at this time to merely distinguish the Yamashita et al. publications.

The Yamashita et al. publication is an English Abstract (the rest is in Japanese) which merely describes the use of titanium sulfate without any specific teaching as to how one might combine this abstract with the teachings of the other references. Further, there are no dual-purpose layers in the Calvert et al. Patent Publication.

In contrast to all three of these references, the present invention described in independent method claims 12, 25, 26, 27, 32, 44, 45 and 47 uses a single layer to accomplish both purposes: to act as both a barrier layer and a seed layer. Because the combination of the Lu et al. Patent Application Publication, the Charneski et al. patent, the Ho et al. patent, the Yamashita et al. publication (JP 2000351622) and Calvert et al. Patent Publication fail to teach such a dual-purpose layer, all the limitations of Applicants claims are not found in the references cited. Therefore, Applicant believes the rejection under 35 U.S.C. § 103(a) now fails. Reconsideration of independent method claims 12, 25, 26, 27, 32, 44, 45 and 47, and the dependent claims which depend upon independent method claims 12, 25, 26, 27, 32, 44, 45 and 47, is respectfully solicited.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney at (612) 373-6904 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743

Respectfully submitted,

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